Materials Processing for ZnO

Stephen J.Pearton, University of Florida, NSF DMR-0400416

We are developing methods of processing ZnO, a very promising material for UV light emission, gas sensing and transparent electronics. The ability to grow ZnO at low temperatures on cheap transparent substrates such as glass may have applications in new generations of electronic and photonics devices that integrate sensors with on-chip signal processing and off-chip optical communication. A first step is to develop etching and contacting techniques that produce working devices. We have recently demonstrated a ZnO-based light-emitting diode in collaboration with SVT Associates.

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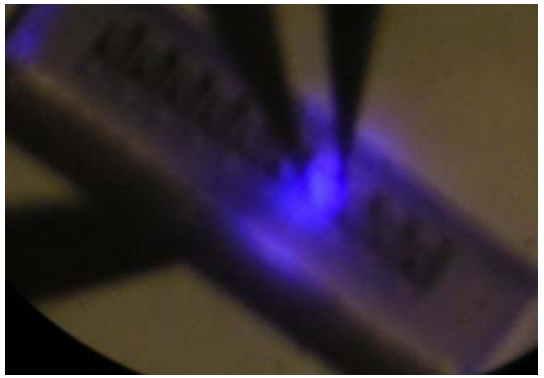
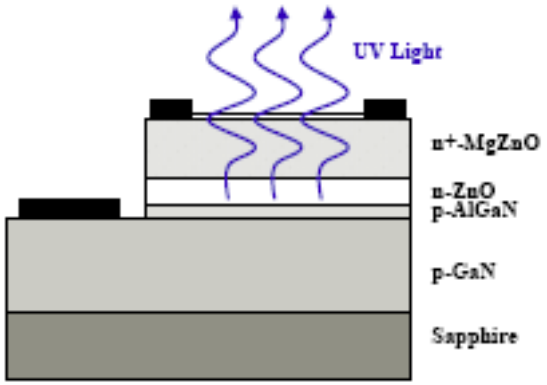


Light Emission from MgZnO/ZnO/MgZnO LED.



Schematic of ZnO-based light-emitting diode.

We have developed new etching and contacting processes for ZnO-based materials and recently collaborated with SVT Associates of Eden Prairie, MN to demonstrate efficient light emission from a ZnO-based light-emitting diode. This shows the effectiveness of our processes and enables us to make a broad range of ZnO structures to study both basic physical properties and possibly have applications in new types of sensors, cheap, efficient light sources and transparent electronics.

Currently the output power measured is about the same as that of a similar GaN LED of the same size and geometry, but in theory the ZnO device will have about an order of magnitude higher intensity at the same voltage because the exciton binding energy (60meV) for ZnO is a lot larger than that in GaN(28meV). The high exciton binding energy means that ZnO will continue to be bright even at high operating temperatures. The basic idea is that ZnO has an advantage in brightness and thus even if it is grown on cheap, low-quality substrates, it will still be very bright, whereas GaN intensity would be impractically low. Essentially then, ZnO will provide more lumens per dollar cost of production of the material. This is where there may be advantages for low-cost lighting.

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Education:

Two graduate students (Rohit Khanna and Kelly Ip) are involved in this new project that started March 1,2004. Kelly Ip is currently on a summer internship at Sandia National Laboratories on the MESA program designed to encourage promising young scientists to consider careers at national laboratories.

Outreach:

The PI presented a general interest talk on "Let there be Light "and designed some simple hands-on experiments for participants in which they could measure resistance of ZnO at different temperatures or in the presence of various types of light.

Participant in the 2004 UF Physics Open House.
Local students from grades 7-12 were present for the lecture and demonstrations.The goal is to expose students to the wonders of the materials they use everyday and to spark their interest in how and where these materials are made. For example, how does a simple light-emitting diode work and why is it not hot to the touch like an incandescent bulb?